Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

superior portion of the löss mantle is in many respects very similar to analogous changes superficially in the aspect of the residuary clays over certain parts of the driftless area lying in the northeastern portion of the state, and the contiguous parts of Illinois and Wisconsin —more specifically referred to by Chamberlain and Salisbury;[1] (3) that the stratigraphic rocks bordering the Mississippi river suffered considerable abrasion during the sojourn of the glacier, as is attested by numerous larger fragments of flint and limestone, which are manifestly not far removed from their origin, and also by the observed surfaces of striation over the elevated portions of the area cartographically represented by fig. 1; and (4) that the till which on the retreat of the glacier nearly, if not entirely, filled preglacially corraded channels has since been more or less completely removed from the numerous deep ravines occurring on all sides of the elevated plateaus of the region.

ON THE INFLUENCE OF CIRCUMSTANCES ON THE ACTIONS AND HABITS OF ANIMALS, AND THAT OF THE ACTIONS AND HABITS OF LIVING BODIES, AS CAUSES WHICH MODIFY THEIR ORGANIZATION.

BY J. B. P. A. LAMARCK.[2]

(Continued from page 972.)

THAT which proves it, is that this is not true of the organ of hearing, which is always found in animals where the nature of their organization requires it. This is the reason. The material of sound, that which is moved by the shock or vibrations of bodies, transmits to the organ of hearing the impression which it has received from them, and penetrates everywhere, traversing all media, and even the masses of the most solid

[1] U. S. Geol. Sur., Sixth Ann. Rep.

[2] Translated by Dr. E. E. Galt, from the edition of 1809.

bodies; any animal which possesses a plan of organization in which hearing is essential, has always occasion to exercise this organ in whatever place it inhabits. Therefore, among vertebrate animals, one sees none which are deprived of the organ of hearing; but below them, when the same organ is wanting, we do not find this sense in any of the animals of succeeding classes. It is not thus with the organ of sight, for one sees that organ disappear, reappear, and disappear again, by reason of the possibility or the impossibility of the animals exercising it. In the *Mollusques acephales*, the great development of the mantle has rendered their eyes and their head altogether useless. These organs, although taking part in a wider plan of organization which comprehends them, have necessarily disappeared and become obliterated by constant disuse. Finally it enters into the plan of organization of reptiles, as of other vertebrate animals, that they should have four feet belonging to their skeletons. Serpents should have, consequently, also four feet, the more so as they do not constitute the last order of reptiles, and since they are less related to fishes than are batrachians (frogs, salamanders, etc.). Now, snakes having adopted the habit of crawling on the ground, and of hiding themselves under bushes, their bodies, in consequence of long-repeated efforts to elongate themselves, in order to pass into narrow places, have acquired a considerable length, and in no wise proportionate to their thickness. Now, feet would have been very useless to these animals, and without employment. Long feet would have been a hindrance to creeping, and very short feet, even to the number of four, would have been incapable of moving their bodies. Thus, the disuse of these parts having become constant in the races of these animals, has caused these same parts to disappear entirely, although they were really in the plan of organization of animals of their class. Many insects, which from the natural character of their order, and also of their genus, should have wings, lack them more or less completely, from disuse. Numbers of Coleoptera, Orthoptera, Hymenoptera, and Hemiptera, etc., present examples, their habits never permitting them to make use of their wings. But it is not enough to give the explanation of the cause which has brought about the condition of organs of different animals, conditions which one sees always the same in those of like species. It is necessary besides to show these changes of conditions acting in the organs of some one individual during its life as the sole result of a great change in the habits peculiar to the individuals of its species. The following remarkable fact fully proves the influence of habits on the condition of organs, and how continued changes in the habits of an individual bring changes in the state of the organs which enter into action during the exercise of these habits. M. Tenon, member of the Institute, has communicated to the *Classe des Sciences,* that having examined the intestinal canal of many men who have been ardent drinkers during a great part of their life, has constantly found it shortened to an extraordinary degree compared with the same organ of all those who had not a like habit. It is known that great drinkers or those who are given to drunkenness, take very little solid food; that they eat almost nothing, and that the drink which they take in abundance and frequently, suffices for their nourishment. Since fluid aliment, and, above all, spiritous drinks, do not remain long either in the stomach or in the intestines, the stomach and the rest of the intestinal canal loses in drunkards the habit of distention. So also in persons of sedentary habits, and constantly applied to mental work, who habituate themselves to take very little nourishment. Gradually, in time, their stomachs contract, and their intestines become shortened. It is not a question here of shrinking and shortening produced by a contraction of parts which would permit of ordinary extension, if in place of a maintained vacancy these viscera should become filled; but it is a question of real shrinks ing and considerable shortening, so that these organs would rather burst than yield suddenly to the causes which would produce ordinary distension. Circumstances of age being entirely equal, compare a man who habitually devotes himself to studies and mental work, who has rendered his digestion sluggish, has contracted the habit of eating very little, with another who habitually and often takes much exercise and eats well; the stomach of the first would have reduced functions, and a very small quantity of aliment would fill it, whilst that of the second would be preserved and even increased. See then an organ greatly modified in its dimensions and functions by the one cause of a change in its habits during the life of the individual. The frequent employment of an organ in becoming adapted to its habits, augments the function

PLATE XXIV.

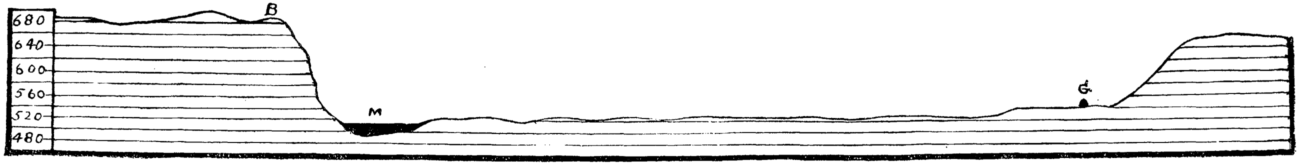

FIG. 1.

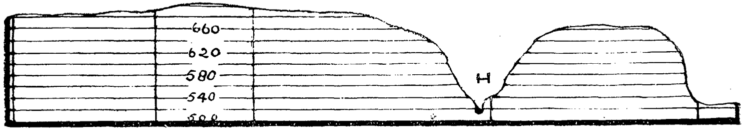

FIG. 2.

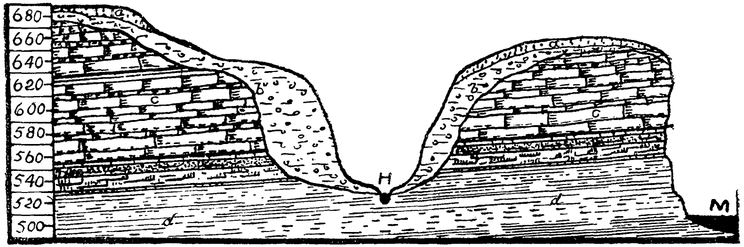

FIG. 3.
Sections at Burlington, Iowa.

of that organ, develops it, and makes it acquire dimensions and force of action which it has not in animals which exercise it less. One comes to see that the disuse of an organ which has existed, modifies, impoverishes, and finally obliterates it. I will now demonstrate that the continual employment of an organ, with the efforts made in keeping its place in the circumstances under which it exists, strengthens, extends, and increases that organ, or creates new ones which are able to exercise the functions which have become necessary.

The bird that hunger (necessity) attracts to water to find there the prey on which it lives, separates its toes and its feet when it strikes the water, and moves on its surface. The skin which unites these toes at their base, acquire the habit of extending themselves by these perpetual spreadings; thus, after a time, the large membranes are formed which we see uniting the toes of ducks, geese, etc. The same efforts made to swim, that is to say, to push the water in order to advance and move in that liquid, have developed the same membrane which is between the toes of frogs, sea-turtles, the otter, the beaver, etc. On the contrary, the bird that its manner of life habituates to roost in trees, and who proceeds from individuals who have all contracted that habit, has necessarily the toes more elongated and shaped otherwise than those of aquatic animals which I have cited. Their nails, after a time, become long, sharp, and curved in a hook by holding so often the limbs on which the animal rests. So it is known of river birds who do not swim, and who only desire to approach the borders of the water to find their prey, are continually exposed to being forced into the mud. Now this bird, wishing to act so that its body may not be wet, makes great efforts to extend and elongate its feet. It follows from the continued habits which this bird, and all those of its race have contracted in continually extending and elongating its legs, that the individuals of this race are found elevated on stilts, and have also gradually obtained long boots. That is to say, they are denuded of feathers as far as the thighs and often beyond (*Systeme des Animaux sans Vertebres*, p. 14). It is known also that the same bird, wishing to pick without wetting its body, is obliged to make continuous efforts to elongate its neck. Now, to the continuance of these habitual efforts in this individual, and those of its race, they owe that, after a time, they acquire the singular elongation of the neck, as is seen in river birds.

If some swimming birds, as the swan and the goose, and of which the feet are short, have, nevertheless, a very long neck, it is because in walking in the water they have the habit of plunging their heads below as deeply as they are able, to take the aquatic larvæ and different animalcules which nourish them, and that they have no reason for stretching their feet. If an animal, for the satisfaction of its wants, should make repeated efforts to elongate its tongue, it would acquire considerable length (*e.g.*, the ant-eater, the "pic-verd"). If it wants to seize something with the same member, then its tongue will divide and become forked. That of humming-birds, who seize with their tongue, and of lizards and snakes, who use theirs to feel and investigate bodies which are before them, are the proofs of that which I advance. Wants, always occasioned by circumstances, and followed by continued efforts to satisfy them, are not limited in their results to modify, that is to say, to augument or diminish, the extent or the functions of these organs, but they succeed in displacing these same organs where certain of these wants make it a necessity.

Fishes which swim habitually in large bodies of water, having occasion to see laterally, have their eyes placed on the sides of the head. Their body, more or less flattened according to the species, has its edges perpendicular to the plane of the water, and their eyes are placed in such a manner that they have an eye on each flattened side. But those fishes whose habits involve the necessity of constantly approaching rivers, particularly rivers little inclined or with gentle descent, have been forced to swim with one side downwards in order to be able to approach near the edges of the water In this situation, receiving more light from above than below, and having particular reason for always being attentive to that which they find above the water, this want has forced one of their eyes to undergo a kind of displacement, and to take the very singular situation which is known in soles, turbots, "limandes," etc. (the Pleuronectes and the "Achires"). The situation of these eyes is not symmetrical, because there has resulted an incomplete mutation· Now this mutation is entirely finished in the rays, where the transverse flattening of the body is altogether horizontal; so with the head. Thus the eyes of rays, both placed on the superior face, are rendered symmetrical.

Snakes which crawl on the surface of the earth, having reason principally to see elevated objects, or those which are above them, this necessity has influence on the situation of the organ of sight in these animals, and, in fact, it has placed the eyes in the lateral and superior part of the head, in position to perceive easily that which is above them or at their sides, but they cannot see that which is above them or but little distance in front. Now, forced to make up for the lack of sight in recognizing objects which are before them, and which might hurt them in advancing, they have been able to feel these objects only by aid of their tongue, which has obliged them to stretch it out with all their might. This habit has not only contributed to render this tongue thin, very long, and very contractile, but further, has forced it to divide itself, in a great number of species, to feel several objects at a time; it has formed an opening at the extremity of their muzzle, to pass without being obliged to open the jaws.

Nothing is more remarkable than the production of habits in herbivorous mammals. The quadrupeds to which circumstances and the wants which they have brought about, have given the habit of browsing on herbs, walk only on the earth, and find themselves obliged to rest on their four feet the great part of their life, executing generally few of the ordinary movements of other Mammalia. The considerable time which this kind of animal is forced to employ every day, to replenish itself with the only kind of food which it uses, requires that it make little movement, that it employ only its feet to sustain itself on the ground, to walk or run, and that it never exerts itself to hang to or to grasp the trees. From this habit of consuming all day, great quantities of alimentative materials which distend the organs which receive it, and of making only ordinary movements, it has resulted that the bodies of these animals are considerably thickened, become heavy and massive, and have acquired a very great volume, as one sees in the elephant, rhinoceros, cattle, buffalo, deer, etc.

The habit of resting upright on their four feet during the greater part of the day to browse, has caused a thick hoof to grow, which envelope their toes; and as these toes are resting without exercising any movement, and are serving no other purpose than to sustain them as well as the rest of the foot, the greater part of them are shortened, are obliterated, and so finally disappear. Thus, in the pachyderms, some have five toes on the feet enveloped in horn, and in consequence their hoof is divided into five parts; others have only four, and others still only three. But in the ruminants, the most ancient of mammals, which are confined to sustaining themselves on the ground, there are only two toes to the feet. It is also found that there is but one toe in solipedes (the horse, the ass). Now, among these herbivorous animals, and particularly among the ruminants, it is found that, from the circumstances of the wild country which they inhabit, they are constantly exposed to become the prey of carnivorous animals, and to be able to find safety only in precipitate flight. Necessity has then forced them to exercise themselves in rapid running; and from the habit which they have acquired, their bodies have become more slight, and their limbs slenderer: one sees examples in the antelope, gazelles, etc. The deer, roe-buck, fallow-deer, etc., are exposed to perish by the chase, or pursuit by man. This risk has reduced them to the same necessity, has constrained them to the same habits, and has produced the same results in them. The ruminant animals, being able to use their feet only to sustain themselves, and having little strength in their jaws, which are used only in cropping and browsing the herbs, they are able to strike blows only with the head, directing one against the other with the top of that region. In their fits of rage, which are frequent, especially among the males, their "sentiment interieur," by these efforts directs more strongly the fluids toward that part of the head, and causes there a secretion of horny material in some, and of both osseous and horny material in others, which gives to them solid protuberances. This is the origin of horns and bosses, with which the greater number of these animals have the head armed. It is curious to observe the product of the habits in the peculiar form and the height of the giraffe (*Camelopardalis*). It is known that this animal, the tallest of mammals, inhabits the interior of Africa, and that it lives in places where the earth is almost always arid and without herbage, so that it is obliged to browse the leaves of the trees, and to force itself continually to reach them. It results from this long-continued habit, in all individuals of its race, that the front limbs have become longer than the hind ones, and that its neck is much elongated; that the giraffe, without rising on its hind feet, elevates its head and attains to six metres in height (nearly twenty feet).

Among birds, the ostriches, deprived of the faculty of flight, and elevated on very high limbs, truly owe their singular conformation to analogous circumstances. The result of habits is also as remarkable in carnivorous mammals as it is in the herbivorous, but it shows its effects in another way. In fact, those mammals who are habituated, as well as their race, to climb, to scratch, in order to excavate the earth; to rend, to attack; to put to death other animals which may be their prey, have had occasion to use their toes. Now, this habit has favored the separation of their toes, and on them has formed the claws with which we see them armed. Among the carnivores it is found that they are obliged to employ the chase to take their prey. Now, those of these animals who want, and consequently have the habit of rending with the claws, are compelled to force them deeply into the body of the other animal in order to hold it, and afterwards the effort made to tear the seized part has, by these repeated efforts, procured for those nails a size and a curve which would then have impeded them much in walking or running on stony ground. It results in this case that the animal has been obliged to make efforts to draw back these too projecting and crooked claws, and it results in, little by little, the formation of these peculiar grooves into which cats tigers, lions, etc., retract their claws when not in use. Thus, efforts in some directions, long-continued or habitually made by certain parts of a living body to satisfy wants caused by nature or by circumstances, increase these parts, and they acquire dimensions and a form which they would never have attained if these efforts had not become the habitual action of the animals which employ them. Observations made on all known animals would everywhere furnish examples of it. What is more striking than what the kangaroo offers us? This animal, which carries its little ones in the pouch which it has under its abdomen, has acquired the habit of holding itself upright, poised only on its hind feet and on its tail, and of moving only by the aid of a series of leaps, in which it preserves its upright attitude so as not to hurt its little ones.

Behold, then, what is the result? First.—Its front legs, of which it makes very little use, and upon which it supports itself only an instant when it leaves its upright attitude, have never acquired a development proportional to those of other parts, and have remained slender, very small, and almost without strength. Second.—The hind limbs, almost continually in action to sustain all the body, when leaping, have, on the contrary, attained a considerable development, and have become large and strong. Third.—Finally, the tail, which we see greatly employed in sustaining the animal, and in executing its principal movements, has acquired at its base a breadth and a force extremely remarkable. These well-known facts are assuredly well calculated to prove that which results from the habitual use by animals of an organ or of some part. If, when we observe in an animal an organ particularly developed, and strong and powerful, it is claimed that its habitual exercise has done nothing to produce that result; that its continued disuse makes it lose nothing, and that, finally, this organ has always been such as we find it since the creation of the species to which this animal belongs, I demand why our domestic ducks are not able to fly as the wild ducks; in a word, I will bring a multitude of examples to our notice, which will attest the differences resulting to us from the exercise or the lack of exercise of some of our organs, although these differences be not maintained in successive generations. In that case their results might be still more considerable. I observe, in the second place, that when the will determines an animal to some action, the organs which should execute this action are immediately excited by the influence of subtle fluids (of the nervous fluid), which becomes the determining cause of the movements which cause the action in question. A multitude of observations prove this fact. It results that the multiplied repetitions of these acts of organization strengthen, expand, develop, and also create the organs which are necessary. It is necessary only to observe attentively that which happens everywhere in this respect, to be convinced of the basis of this cause of the development of organic changes.

Now, all changes acquired in an organ in consequence of a habit employed sufficiently to have an effect, is preserved afterward by generation, if it is common to the individuals who in fecundation unite for the reproduction of their species. Finally this change is propagated and passes thus into all the individuals which follow, and who are placed in the same circumstances, without which they would be obliged to acquire it in the same manner in which it has already been created. Moreover, in these reproductive unions, the mixture between individuals which have different qualities and forms, necessarily opposes the constant propagation of these qualities and forms.

I.—It is this which prevents in man, accidental qualities or defects due to circumstances to which he is exposed from preserving and propagating themselves by generation.

II.—If two individuals who have acquired peculiarities of form or defects be united, in this case they will reproduce the same peculiarities in successive generations. And if they restrict themselves to like unions, a particular and distinct race will then be formed. But the perpetual mixture between individuals which have not the same peculiarities of forms will destroy all the peculiarities acquired by particular circumstances. From this one can be assured that if distances of habitation had not separated men, the crossing, by generation, would have destroyed the general characters which distinguish different nations. If I should pass in review all the classes, all the orders, all the genera, and all the species of animals which exist, I would be able to show that the conformation of individuals and of their parts, that their organs, their functions, etc., etc., are everywhere only the result of circumstances in which every species finds itself surrounded by nature, and of the habits which the individuals which compose it have been obliged to adopt, and that they are not the result of an existing primitive form which has forced these animals to adopt their habits.

It is known that the animal which is called the Aï, or the sloth, (*Bradypus tridactylus*), is constantly in a state of so great feebleness that it executes very slow and limited movements, and that it walks with great difficulty on the ground. Its movements are so slow that it is claimed that it is able to take only fifty steps in a day. It is known also that the organization of this animal is in all respects harmonious with its condition of feebleness or its inability to walk, and that if it wished to make other movements than those which it is known to execute, it would not be able. If we suppose that this animal has received from nature the organization which it possesses, we must believe that this organization has forced it to adopt the habits and miserable state in which it is found. I hesitate to believe thus, for I am convinced that the habits which the individuals of the race of the Aï have been forced to contract originally, have necessarily brought their organization to its present state. That since continual danger has formerly made the individuals of this species take refuge in trees, to live there habitually, and to sustain themselves there on their leaves, it is evident that they must be deprived of a multitude of movements which animals who live on the ground are in the habit of making. All the wants of the Aï have been then reduced to the hanging on the branches, to creeping, or to crawling to get the leaves, and afterwards to resting on the tree in a state of inactivity, and always to avoid falling to the earth. Besides, this kind of inactivity would be constantly encouraged by the heat of the climate; for, with animals of warm blood, heat predisposes them more to rest than to movement. Now, the individuals of the race of the Aï having for a long time preserved the habit of resting on trees, and of making only slow and little varied movements which suffice for their wants, their organization, little by little, would be brought into harmony with their new habits, and this would be the result: 1st.—That the arms of these animals making continual efforts to embrace easily the branches of the trees, will have lengthened; 2d.—That the nails of their toes will have acquired much length and a curved form by sustained efforts to cling; 3d.—That their toes, having only exercise in particular movements, will have lost all mobility, will have reunited, and will have preserved only the ability of bending or of straightening themselves altogether; 4th.—That their thighs, embracing continually the trunk and the great branches of the trees, will have contracted an habitual bowing, which will have helped to enlarge the pelvis, and to direct the cotyloid cavities backward; 5th.—Finally, that a great number of their bones will have consolidated, and that thus many parts of their skeleton will have acquired a tendency and a form appropriate to their habits, and contrary to those which they would have had under other habits.

No one is able to contest this, since nature, in a thousand other ways, constantly shows us analogous examples of the power of circumstances on the habits, and in that of habits on the forms, the disposition,and the proportion of the parts of animals. A great numder of citations being unnecessary, the point of discussion reduces itself to this. The fact is, that diverse animals have each, according to their genus and their species, particular habits, and always an organization which is perfectly in harmony with those habits. From the consideration of this fact it seems that one is at liberty to admit one or the other of the two following hypotheses, neither of which can be proved.

Conclusions admitted at this time: (1) Nature (or its Author, in creating animals has foreseen all possible kinds of circumstances in which they may have to live, and has given to each species a permanent organization, as well as a pre-determined form invariable in its parts; that it forces each species to live in the places and the climates where one finds them, and to preserve there the habits which it has. 2. My own conclusion : Nature in producing successively all species of animals, and commencing by the most imperfect or simple, to terminate its work by the most perfect, has gradually complicated their organization, and these animals, spreading themselves gradually into all habitable regions of the globe-each species has been subjected to the influence of the circumstances in which it is; and these have produced the habits which we observe and the modifications of its parts.

The first of these two conclusions is that which has been held to the present time, that is to say, it supposes in each animal a permanent organization and parts which have never varied and which will never vary; it supposes still thatthe circumstances of the places which each species of animal inhabits never vary in these places) for if they should vary, the same animals would not be able to live there, and the possibility of recognizing such elsewhere, and of going or transporting themselves there, would be denied them.

The second conclusion is mine. It supposes that, by the influence of circumstances on the habits and that which follows these habits on the organization, that each animal would receive in its parts and organization, modifications susceptible of becoming very considerable, and thus to have given origin to the state in which we find all animals. To prove that this second conclusion is without foundation, it is necessary to first prove that no point of the surface of the surface of the globe has ever varied its nature, its exposure, its elevation, its climate, etc., etc.; and to prove farther that no part of an animal undergoes, after a length of time, any modifications due to change of circumstances and from the necessity which constrains them to a kind of life and of action different from that which has been habitual with them.

Now, if only one fact proves that an animal, after a long time of domestication, differs from the wild species from which it came, and if among the domesticated species there is found a great difference of conformation among individuals who have been subjected to a given habit, and those who have been constrained to adopt a different habit, then it will be certain that the first conclusion does not conform to the laws of nature and that, on the contrary, the second is perfectly in accord with them. All agree then to prove my assertion: that it is neither the form of the body nor of its parts which gives origin to the habits and the manner of life of the animals; but it is, on the contrary, the habits, the manner of life and all the other influential circumstances, which have, with time, constructed the form of the body and of the parts of the animals. With new forms new faculties have been acquired, and little by little Nature has come to form animals, such as we actually see them.

Can there be in Natural history a more important consideration and to which one should give more attention than that which I expound?